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Upgrading Bridge Rails on Low-Volume Roads in Iowa

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Abstract
Building on previous research, the goal of this project was to identify significant influencing factors for the Iowa Department of Transportation (DOT) to consider in future updates of its Instructional Memorandum (I.M.) 3.213, which provides guidelines for determining the need for traffic barriers (guardrail and bridge rail) at secondary roadway bridges—specifically, factors that might be significant for the bridge rail rating system component of I.M. 3.213. A literature review was conducted of policies and guidelines in other states and, specifically, of studies related to traffic barrier safety countermeasures at bridges in several states. In addition, a safety impact study was conducted to evaluate possible non-driver-related behavior characteristics of crashes on secondary road structures in Iowa using road data, structure data, and crash data from 2004 to 2013. Statistical models (negative binomial regression) were used to determine which factors were significant in terms of crash volume and crash severity. The study found that crashes are somewhat more frequent on or at bridges possessing certain characteristics—traffic volume greater than 400 vehicles per day (vpd) (paved) or greater than 50 vpd (unpaved), bridge length greater than 150 ft (paved) or greater than 35 ft (unpaved), bridge width narrower than its approach (paved) or narrower than 20 ft (unpaved), and bridges older than 25 years (both paved and unpaved). No specific roadway or bridge characteristic was found to contribute to more serious crashes. The study also confirmed previous research findings that crashes with bridges on secondary roads are rare, low-severity events. Although the findings of the study support the need for appropriate use of bridge rails, it concludes that prescriptive guidelines for bridge rail use on secondary roads may not be necessary, given the limited crash expectancy and lack of differences in crash expectancy among the various combinations of explanatory characteristics.

Keywords
bridge barrier rails, bridge guardrails, crash severity mitigation, low-volume roads, safety countermeasures, secondary road bridges

Disciplines
Civil Engineering

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tech transfer summary

The goal of this project was to identify factors for the Iowa Department of Transportation to consider in future updates of its Instructional Memorandum (I.M.) 3.213 (Iowa DOT 2013)—specifically, factors that might be significant for the bridge rail rating system component.

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RESEARCH PROJECT TITLE
Upgrading Bridge Rails on Low-Volume Roads in Iowa

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Background

A previous study for the Iowa Highway Research Board (IHRB TR-592) provided an overview of the nation's bridge and approach rail state of practice and of a statewide crash analysis of bridge rails and approach guardrails on low-volume road (LVR) bridges in Iowa. The study found that LVR bridge crashes were rare events, occurring more frequently on bridges with widths of less than 24 ft. Crash rates were found to be higher on bridges with a narrower width compared to the approach roadway width.

Partly as a result of TR-592, changes were made to the guardrail exceptions in I.M. 3.213 to increase the average daily traffic (ADT) exception from 200 vehicles per day (vpd) to 400 vpd and add an exception for bridges with widths greater than the approach roadway width. However, no significant changes were made to the detailed bridge rail rating system component of I.M. 3.213, which is used to determine necessary bridge rail upgrades by assigning points to bridges based on crash history, ADT, width, length, and type of bridge rail. Thus, the current study was a follow-up to and builds on the results of TR-592.

Research Methodology

A literature review was conducted of policies and guidelines in other states and, specifically, of studies related to traffic barrier safety countermeasures at bridges. Bridge railing and guardrails are a Group 3 (high-severity) fixed object/hazard (Stephens 2005). In general, however, for certain roadway characteristics such as LVRs, it may not be necessary or desirable to design bridge railing or guardrail countermeasures to full AASHTO standards. Also, the Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT ≤400 vpd) (AASHTO 2001) recommend that safety improvements should be initiated only when a safety problem exists at a site.

To identify safety problems at bridges on Iowa's LVRs, a safety impact study was conducted. The impact study evaluated possible non-driver-related behavior characteristics of crashes on secondary road structures in Iowa using road data, structure data, and crash data from 2004 to 2013. Negative binomial regression models were used to determine which factors were significant in terms of crash frequency; ordered probit regression model was used to determine the influence of roadway and structure characteristics on the severity of crashes involving bridge components. In the 10-year study period, 846 crashes were retained and used in the analyses.

First, a combined sample set involving the entire secondary road network (statewide) to investigate the effects of the explanatory variables (road and structure characteristics) on the expectancy of bridge crashes for the entire network as a whole was analyzed. Then, separate samples from only paved roads and unpaved roads, respectively, were analyzed. Splitting the network into paved and unpaved secondary systems allowed for more specific parameter estimation for the paved and unpaved systems, which may have exclusive policies and characteristics that cannot be specified as variables.

Several characteristics were identified as possible factors correlated with bridge crashes: traffic volume and percentage of heavy vehicles, roadway cross-section features factors such as lane/shoulder widths and structure length, roadway alignment factors such as the presence of horizontal/vertical curvature, and weather conditions factors such as the presence of rain/snow or low visibility settings. Several factors were excluded from the study for various reasons, leaving the following factors to be considered in the final analyses: traffic volume (ADT), bridge width, bridge length, and bridge age.

Key Findings

The study confirmed previous research findings that crashes with bridges on secondary roads are rare, low-severity events. The study did find that crashes are somewhat more frequent on or at bridges possessing certain characteristics:

- Traffic volume greater than 400 vehicles per day (vpd) (paved) or greater than 50 vpd (unpaved)
- Bridge length greater than 150 ft (paved) or greater than 35 ft (unpaved)
- Bridge width narrower than its approach (paved) or narrower than 20 ft (unpaved)
- Bridges older than 25 years (both paved and unpaved)

No specific roadway or bridge characteristic, including paved or unpaved, was found to contribute to more serious crashes.

Implementation Readiness and Benefits

Although the findings of the study support the appropriate use of bridge rails, it concludes that prescriptive guidelines for bridge rail use on secondary roads may not be necessary, given the limited crash expectancy and lack of differences in crash expectancy among the various combinations of explanatory characteristics.

The conclusions support potential revisions to the Iowa DOT's I.M. 3.213.

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